Columbia/Snake River Mainstem TMDL

Columbia River TMDL Workshops

Vancouver, WA March 25, 2002

Toppenish, WA March 26, 2002

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Agenda

Part 1 - Overview of the Temperature TMDL process to date.

Part 2 - Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

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Part 1

Overview of the Temperature TMDL process to date.

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TMDL Development

- **Model Development ☸**
- **Problem Assessment ☸**
- **TMDL 🗁**

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Why Do We Need A Model?

- **We need to estimate temperatures under un-impounded conditions for which measurement data is scarce**
- **We have conflicting measurements**
- **We do not have measurements at all river locations of interest**
- **We need to estimate influence of different sources**

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Model

- RBM 10
- One Dimensional Energy Budget Mathematical Model.
- Results:
  - Cross sectional averaged temperature
  - Daily or hourly average temperature

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Model Development

- **Developed for the Columbia/Snake TMDL**
- **Peer Reviewed**
- **Intensive Regional Review - industry, contractors, federal agencies.**
- **Numerous public meetings, two public workshops**

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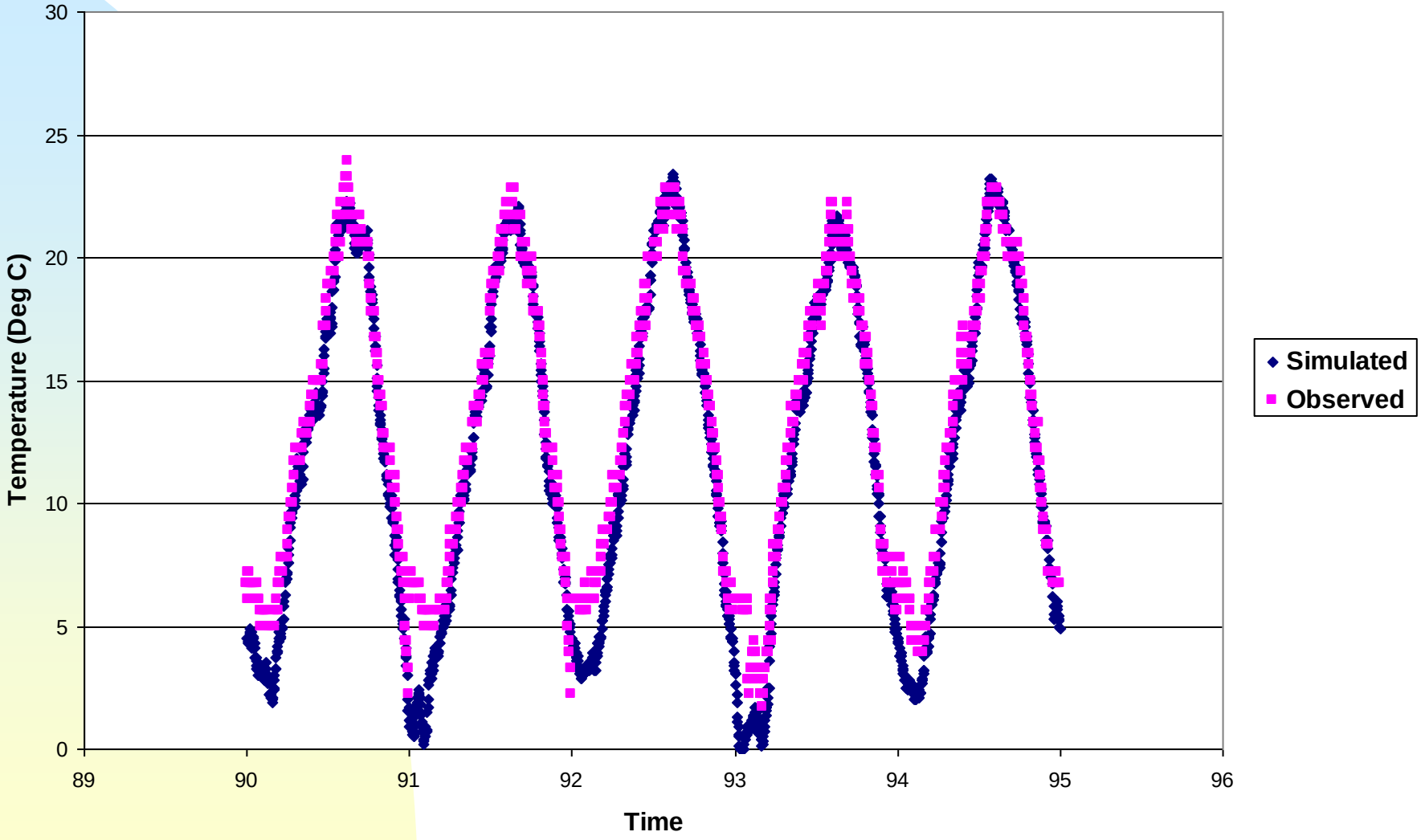
Simulated and Observed Temperature at Bonneville 1990 - 1994



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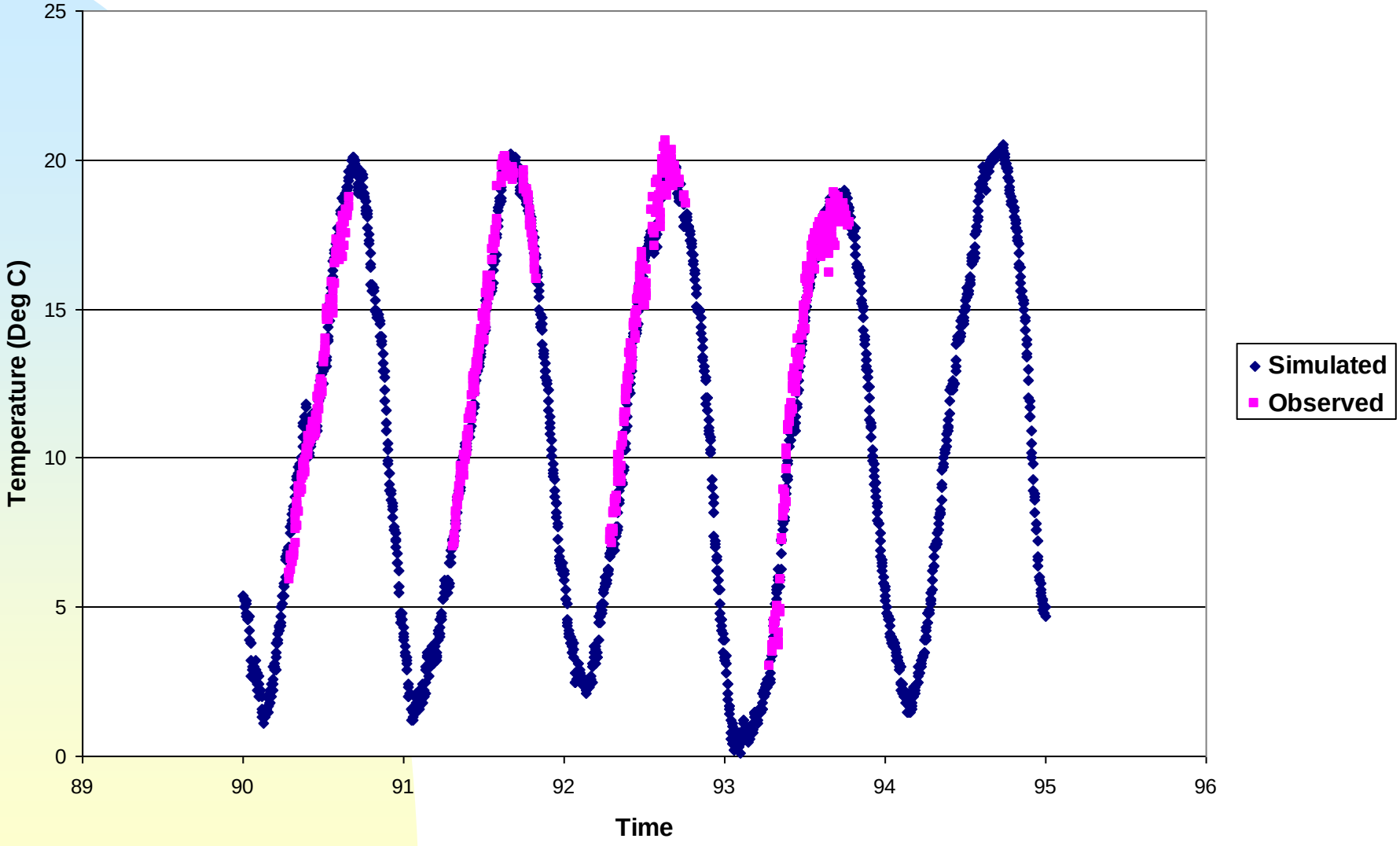
Simulated and Observed Temperatures at Grand Coulee 1990-1994



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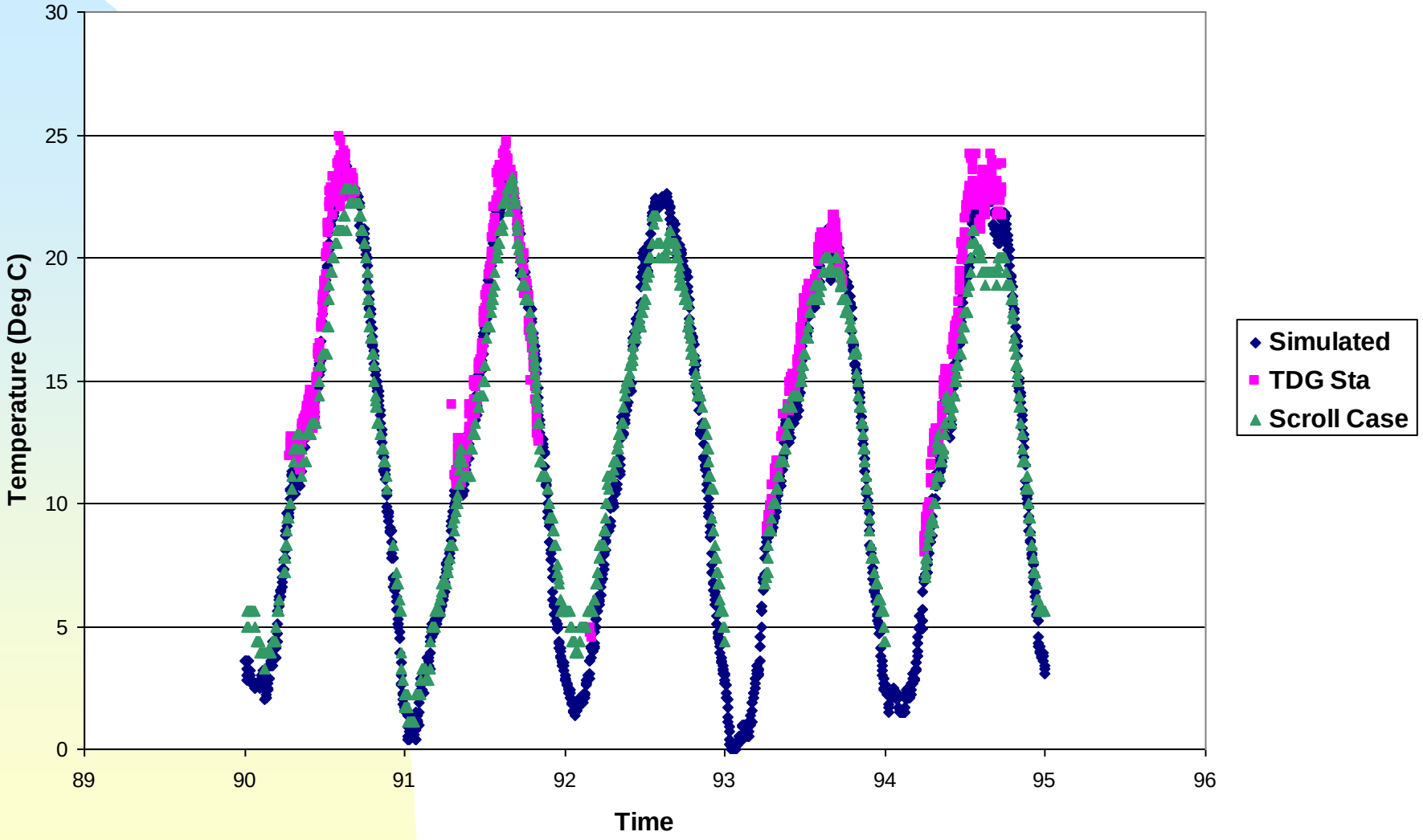
Simulated and Observed Temperatures at Ice Harbor 1990 - 1994



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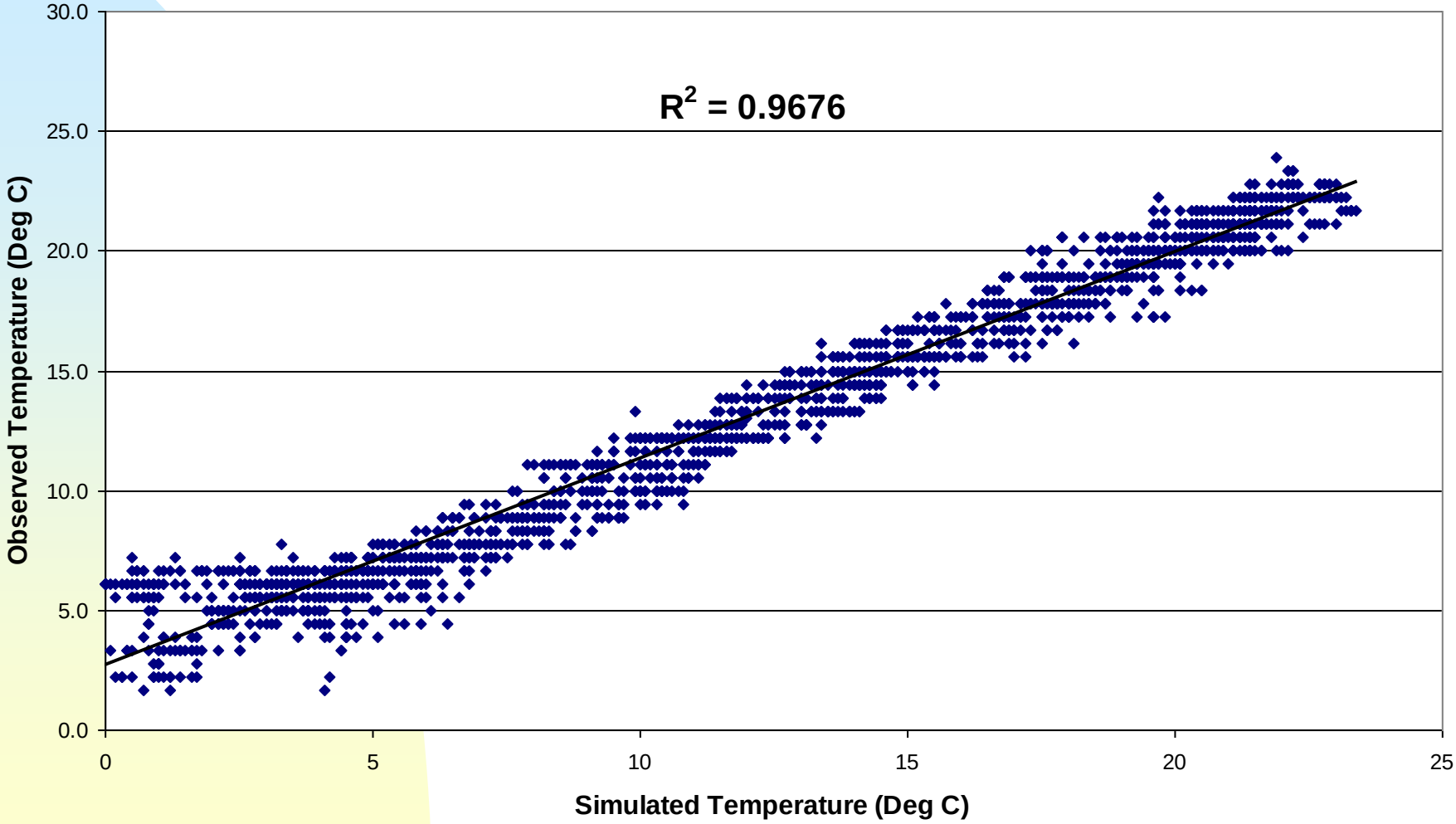
Regression of Observed on Simulated Temperature at Bonneville Dam 1990-1994



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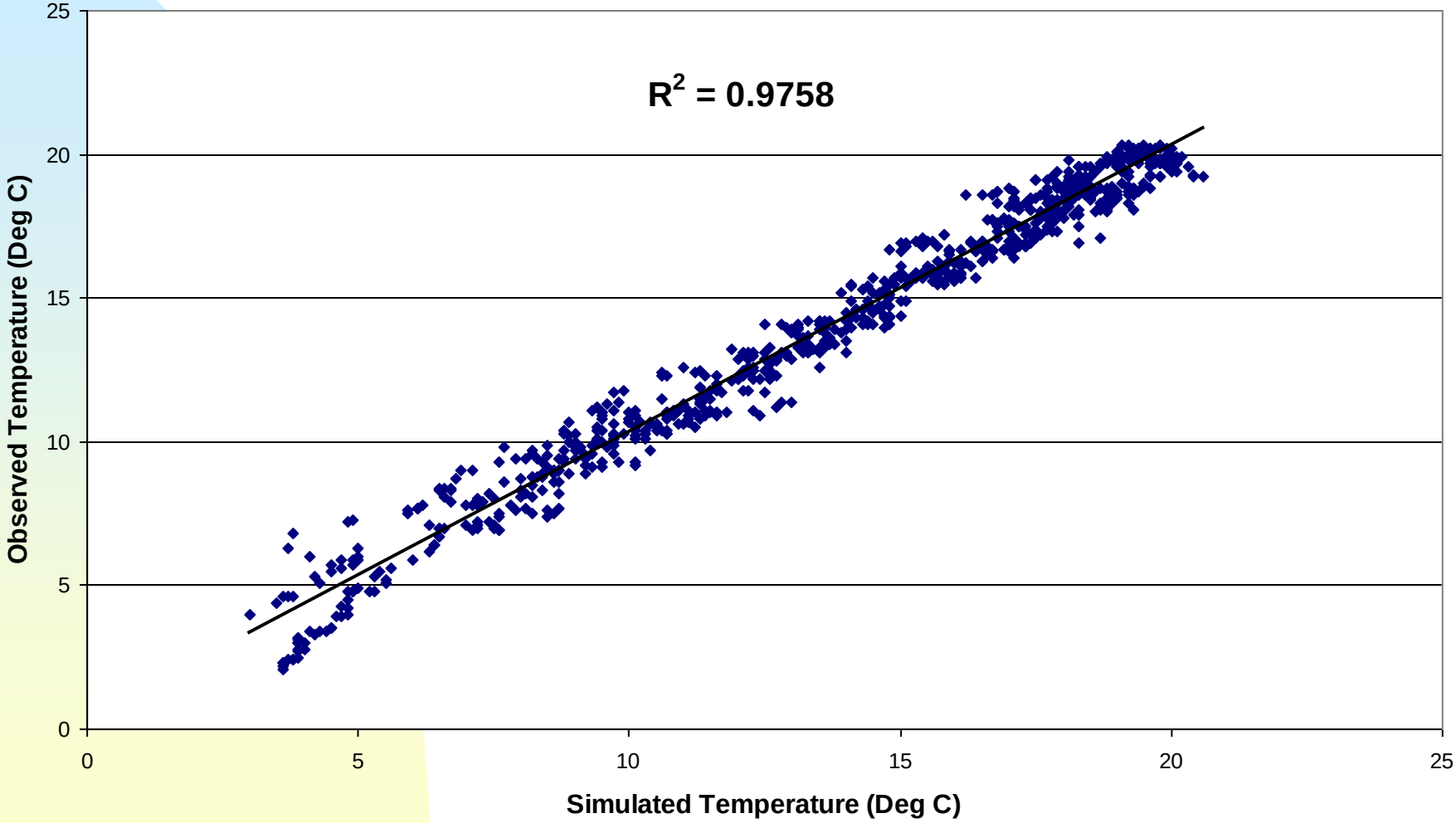
Regression of Observed Temperature on Simulated Temperature
Grand Coulee Tail Race 1990-1994



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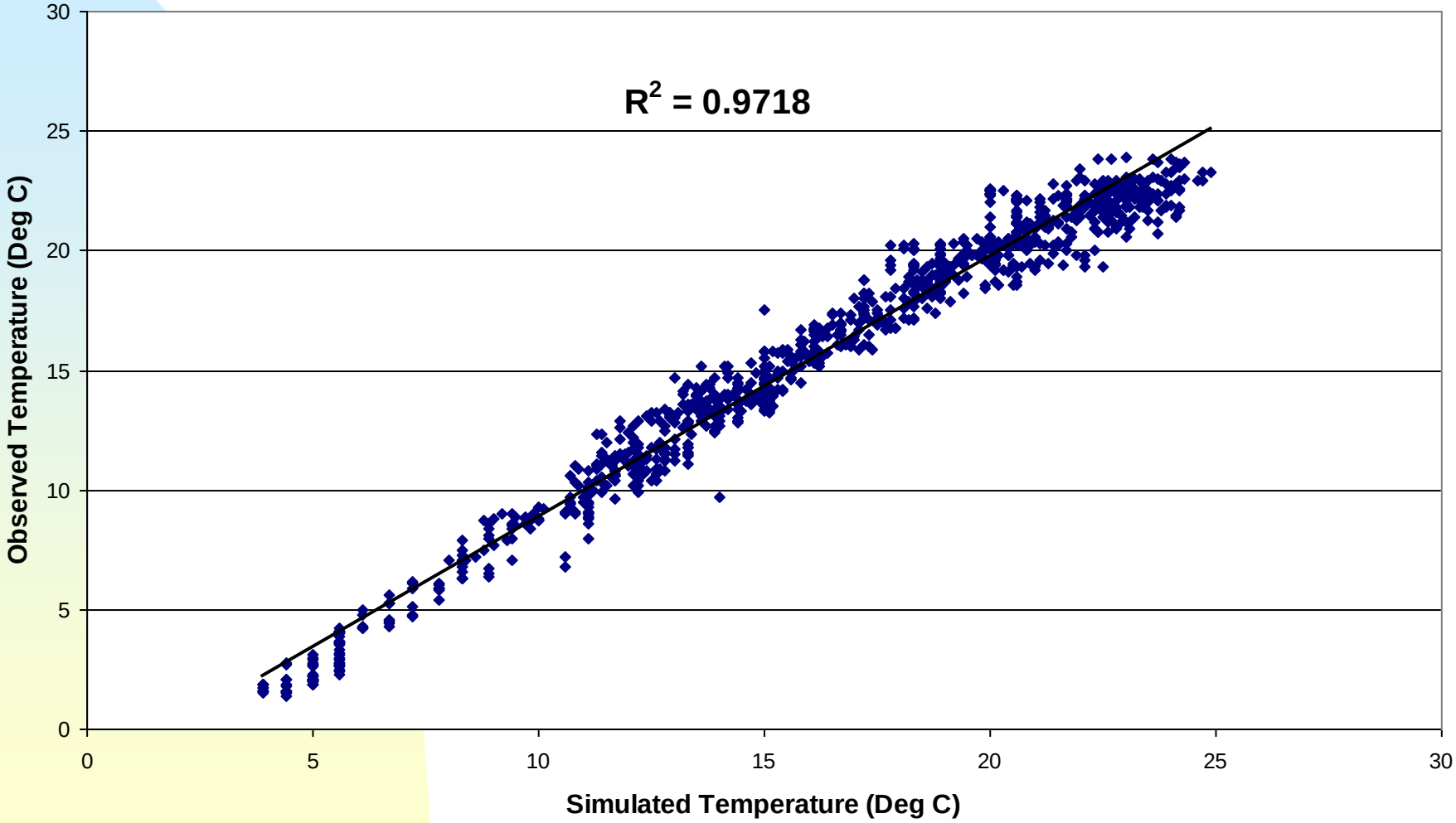
Regression Observed Temperature on Simulated Temperature at Ice Harbor 1990-1994



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RBM 10 Error Estimates

Location	Mean Difference (Obs – Sim)	Standard Deviation
Snake River @ Ice Harbor	0.59*	1.1*
Columbia River @ Grand Coulee	-0.23*	0.73*
Columbia River @ Bonneville	1.0* 0.84**	1.1* 1.18**

- * 1990 – 1994
- ** 1970-1997

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Error Estimates From Other Studies

RISLEY (1997) - Tualatin River

Max Mean Difference = 3 Deg C

Mostly < 1 Deg C

BATTELLE-MASS1 (2001) - Columbia River

RMS Error = 0.59 - 1.52 Deg C

HDR/PORTLAND STATE/IPC (1999) - Snake River

AME = 0.6-2.3 Deg C (1992 data)

AME = 0.5-2.0 Deg C (1995 data)

CHEN (1996) - Grande Ronde River

Error = -2.20 - 8.28 Deg C (Summer Max)

Error = -1.21 - 7.69 Deg C (Avg 7-day Max)

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Problem Assessment

Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

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Problem Assessment

1) Does temperature exceed the Water Quality Criteria?

2) Does temperature exceed the Water Quality Criteria due to human activities?

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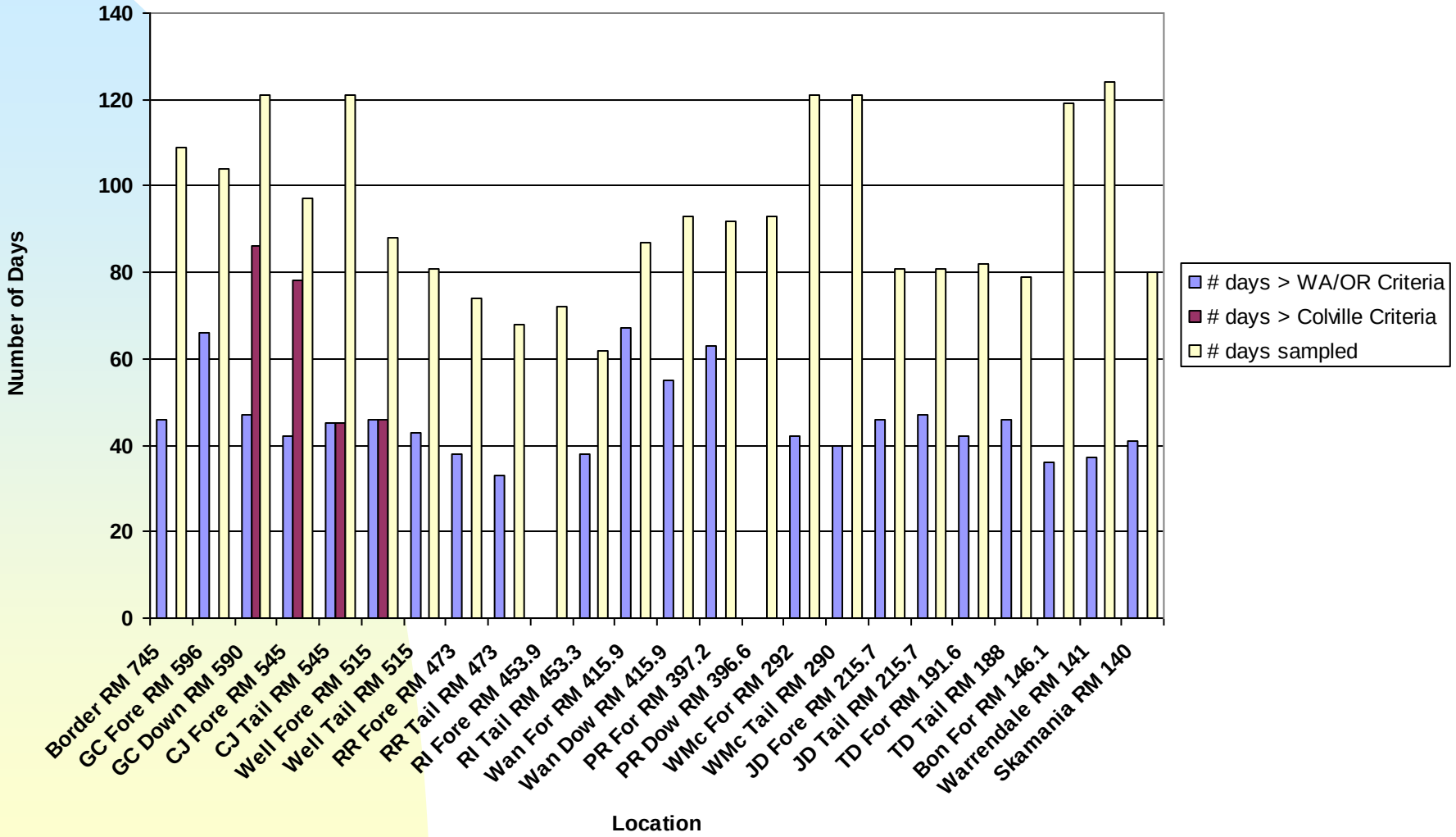
July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



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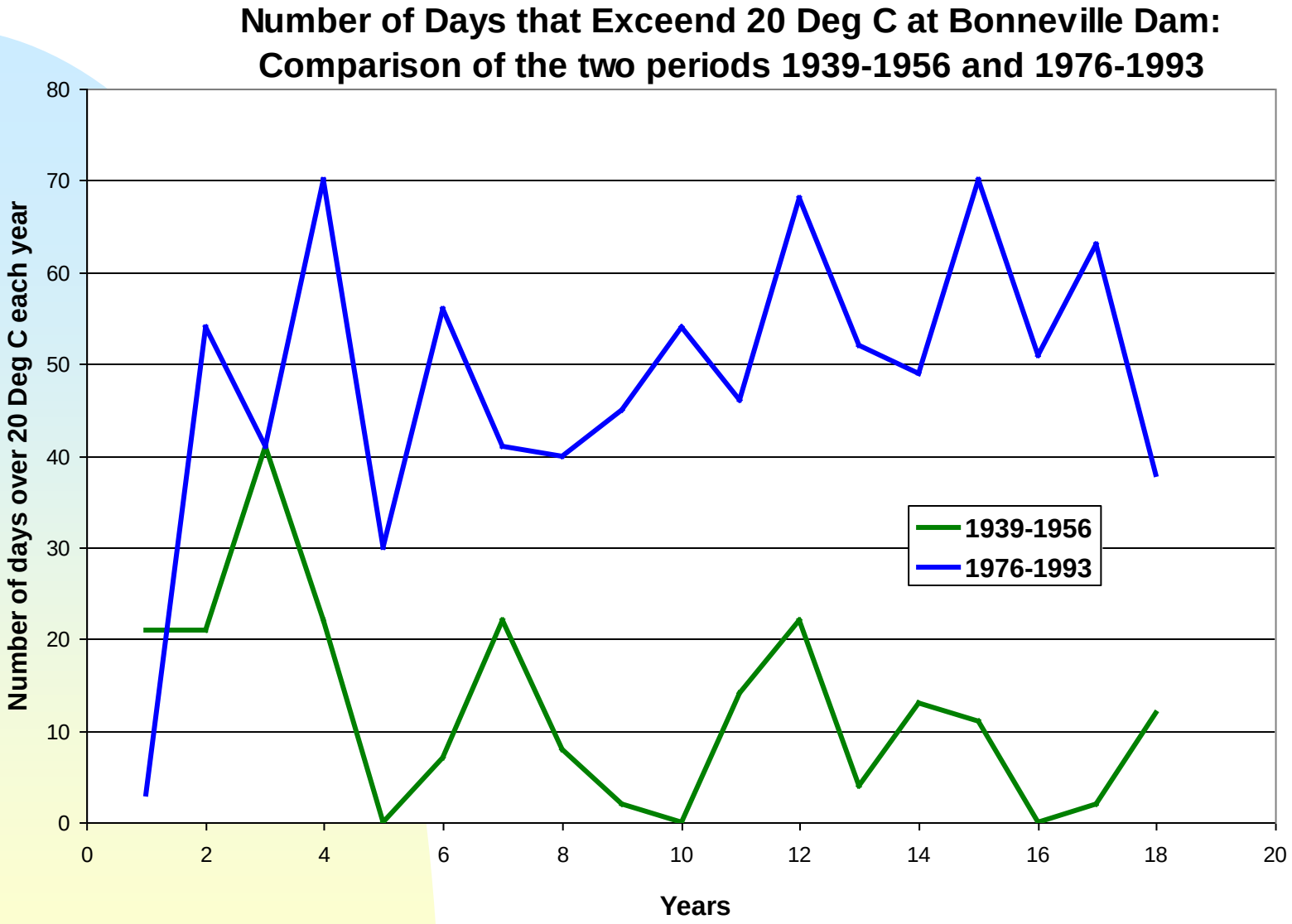

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Problem Assessment

- A significant cause for the altered temperature regime in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.

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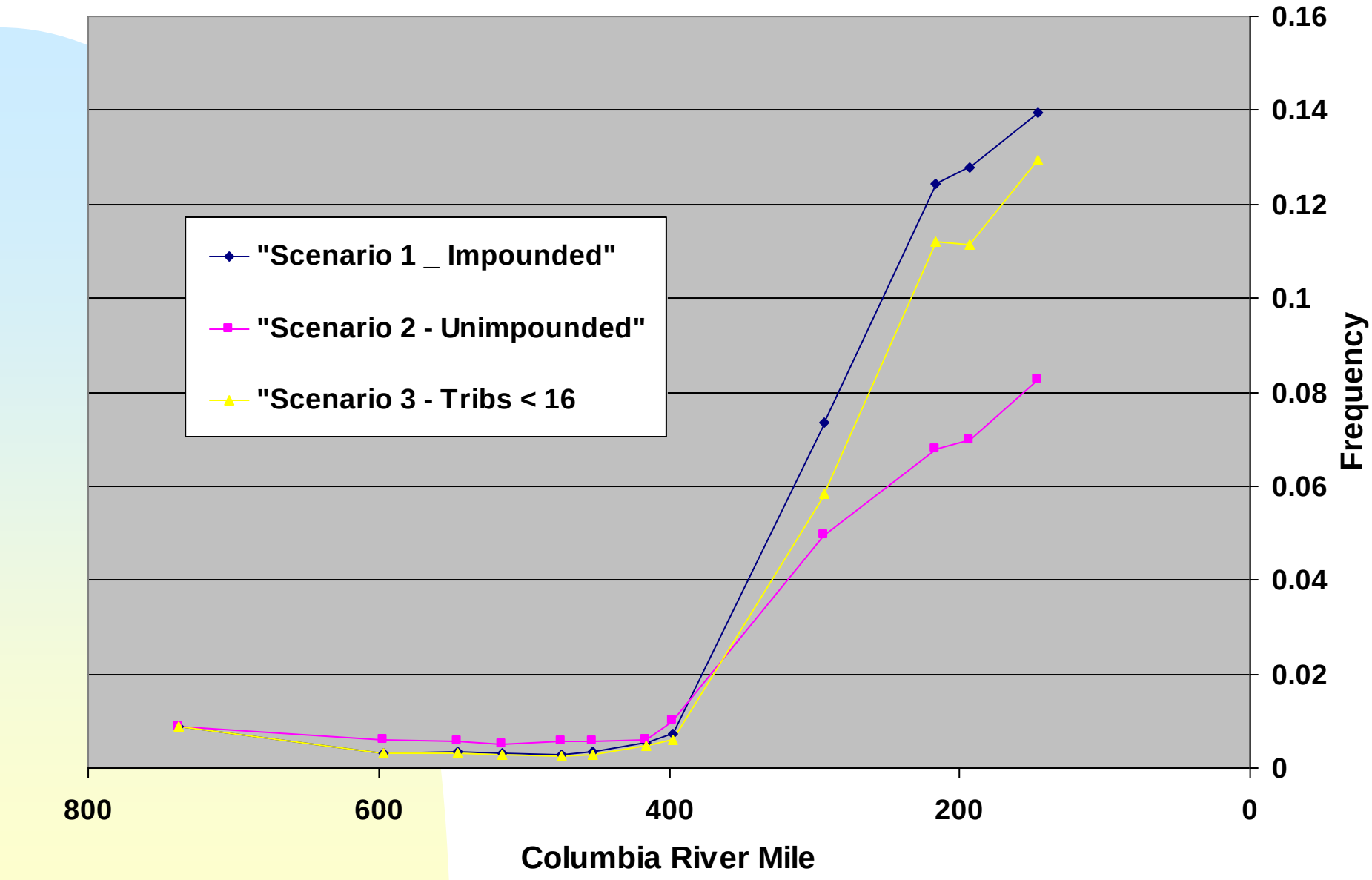

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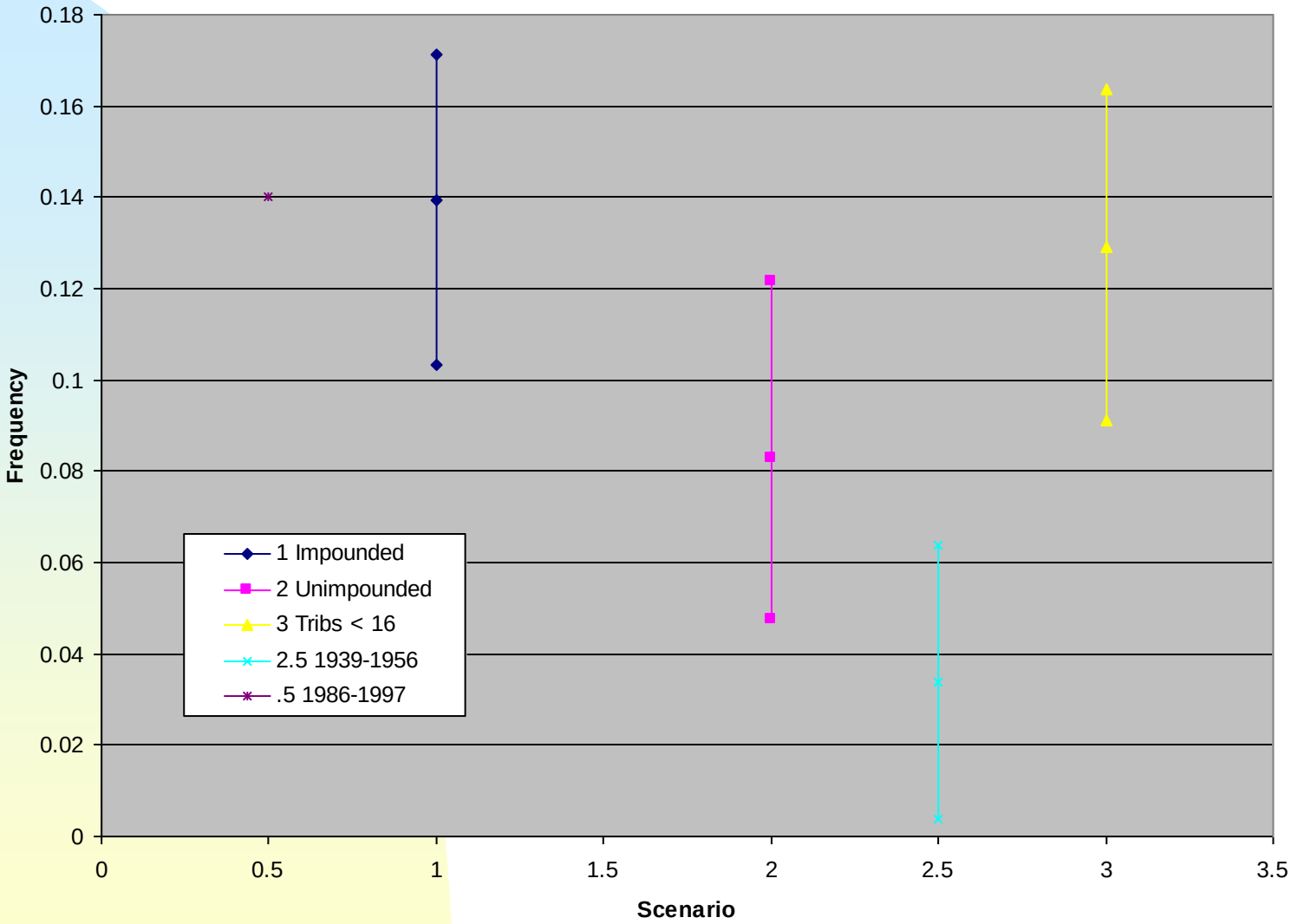
Frequency of Exceedance of 20 deg C at Bonneville Dam: Simulations and Observations



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Part 2

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

1) **Determine Target Temperatures**

2) **Establish Loading Capacity**

3) **Allocate Available Load**

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Water Quality Standards

The WQS for this TMDL are the natural temperatures of the Columbia and Snake main stems plus small incremental increases due to human activity.

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Water Quality Standards

Columbia Main Stem from Coast to OR/WA Border:

"Temperature shall not exceed 20 C (68 F) due to human activities. When natural conditions exceed 20 C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 C (0.5 F) nor shall such temperature increases at any time exceed 0.3 (0.5 F) due to a single source or 1.1 C (2.0 F) due to all such activities combined."

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Water Quality Standards

Colville Standard for Lake Roosevelt:

"Temperature - shall not exceed 16 C due to human activities. Temperature increases shall not at any time, exceed t=23/(T+5).

When natural conditions exceed 16 C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3 C."

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Water Quality Standards

Natural stream temperatures for this TMDL are those that would occur in the main stems within the TMDL study area in the absence of human activity within the main stems in the study area.

They are termed site potential temperatures in this TMDL.

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Water Quality Standards

OR - allow an increase of 0.14 C when the SP > criteria,

- allow increase up to criteria when SP < criteria.

WA & Colvilles

- allow an increase of 0.3 C when the SP > criteria,

-allow reach dependent increases when SP < criteria. Eg t=23/(T+5) is the increase allowed in L. Roosevelt.

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Snake River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Salmon River to OR/WA Border			
	12.8/17.8 C	Up to Criterion	SP + 0.14 C
OR/WA Border to Clearwater River			
	20 C	SP +1.1 C	SP + 0.3 C
Clearwater River to Mouth			
	20 C	SP + 34/(T+9)	SP + 0.3 C

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Columbia River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Canadian Border to Grand Coulee			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Grand Coulee to Chief Joseph			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Chief Joseph to Priest Rapids			
	18 C	SP + 28/(T+7)	SP + 0.3 C
Priest Rapids to OR/WA Border			
	20 C	SP + 34/(T+9)	SP + 0.3 C
OR/WA Border to the Mouth			
	20 C	**SP + 1.1 C**	**SP + 0.14 C**

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Determine Target Temperatures

1. Determine the Site Potential (SP) Temperatures

2. Apply the WQS for each reach.

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Site Potential Temperatures

The site potential temperatures vary temporally and geographically. They vary from day to day and from year to year. They also vary with state or tribal jurisdiction and within jurisdictions they vary along the longitudinal axis of the rivers.

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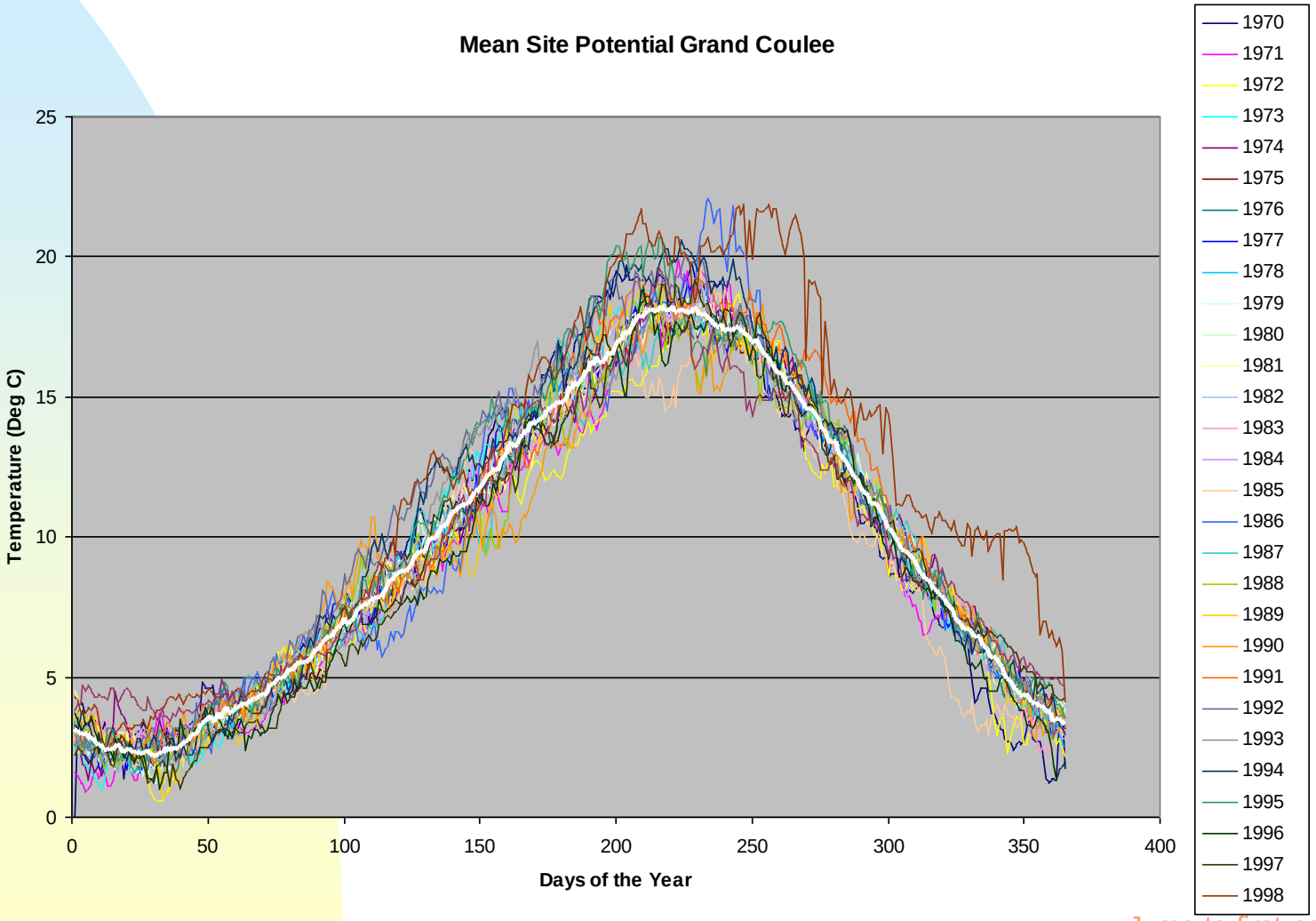
To account for this variability we utilize the mean daily site potential temperatures based on 30 years of simulations using actual weather and flow data.



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Site Potential Temperatures

- We have simulated Site Potential Temperatures for River Reaches.
- The reaches are defined by the dams. There are 15 reaches. The target site for each reach is in the tailrace of the dam at the foot of the reach.
- We have calculated the mean site potential (30 year mean) for each day of the year at each target site.

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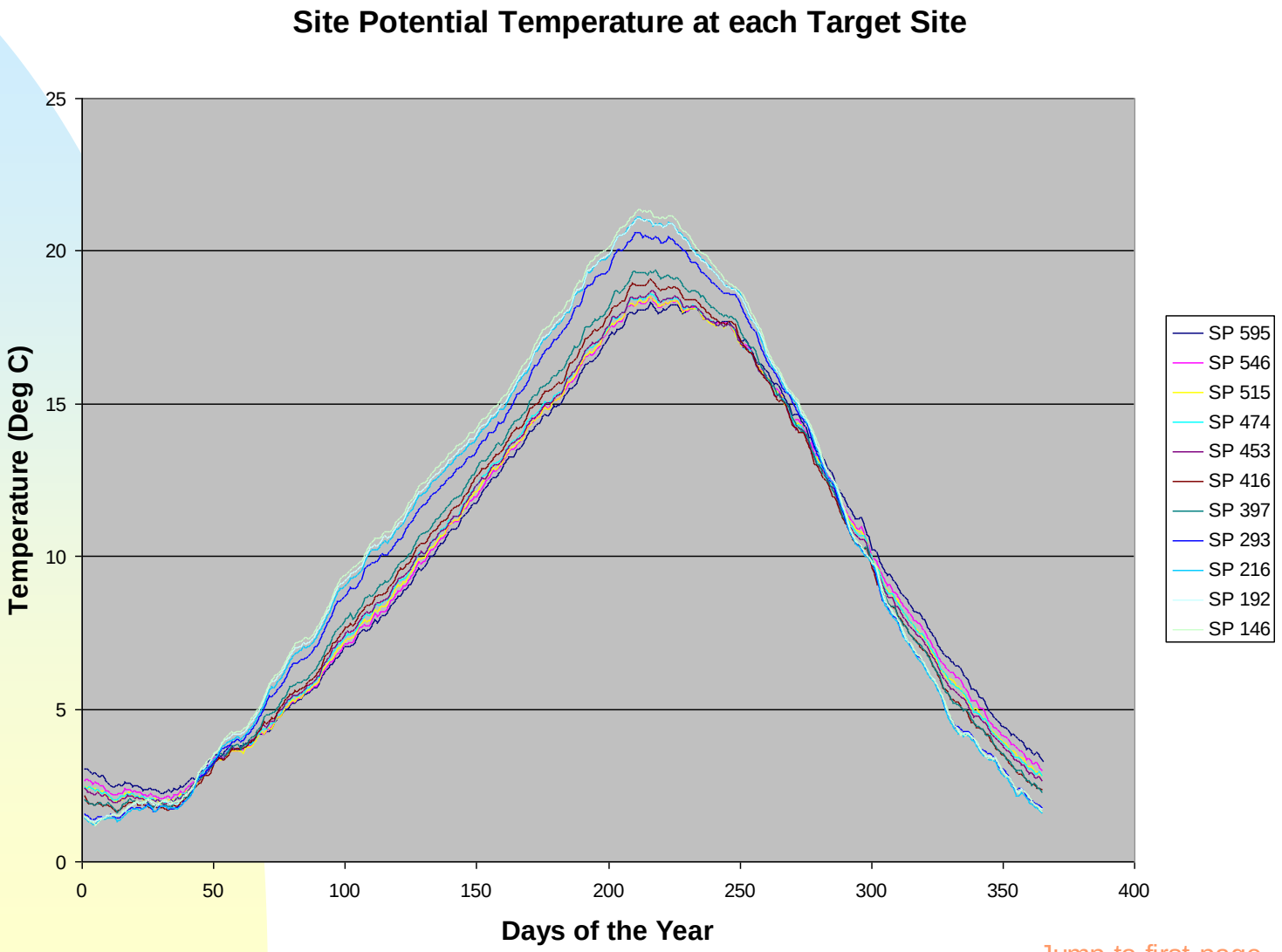
Site Potential Temperatures



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Target Temperatures

- Apply Target Temperatures to the Average SP Reach by Reach.
- Average Target Temperatures based on 30 years of weather and flow data.
- Average Target Temperature for every day of the year for each reach of the rivers.

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Target Temperatures

But…….

There’s a catch!

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Target Temperatures

If we apply the WQS reach by reach to determine the target temperatures reach by reach we will exceed the target temperatures in the downstream reach.

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Columbia River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Canadian Border to Grand Coulee			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Grand Coulee to Chief Joseph			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Chief Joseph to Priest Rapids			
	18 C	SP + 28/(T+7)	SP + 0.3 C
Priest Rapids to OR/WA Border			
	20 C	SP + 34/(T+9)	SP + 0.3 C
OR/WA Border to the Mouth			
	20 C	**SP + 1.1 C**	**SP + 0.14 C**

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Target Temperature

•We need to meet the more stringent WQS: in this case the standards in the lower reach along the border.

•So we need to determine the target temperature in the upstream reaches that will allow achievement of the target temperature in the lower reach.

•Ie: We have to allocate temperature among the upstream sources.

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Target Temperatures

There are many ways to allocate the target temperature:

1. Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.

2. Base the incremental increase for a reach on impacts to temperature in the reach. Eg larger reservoirs get bigger increments.

3. Give the sources above the OR/WA border a “bubble allocation”. The target temperature at the beginning of the reach has to be .14 above SP. Let the sources allocate that among themselves.

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Target Temperatures

We have completed the first example approach: **Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.**

When Site Potential is less than the Criterion:

incremental increase in each reach is 0.15 C

When Site Potential Exceeds Criterion:

incremental increase in each reach is 0.02 C

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Target Temperatures

- Target Temperature @ Grand Coulee Target Site =
  - SP + 0.15 C when SP < Criteria
  - SP + 0.02 C when SP > Criteria

- Target Temperature at each subsequent target site =
  - Upstream Temperature + 0.15 C when SP < Criteria
  - Upstream Temperature + 0.02 C when SP > Criteria

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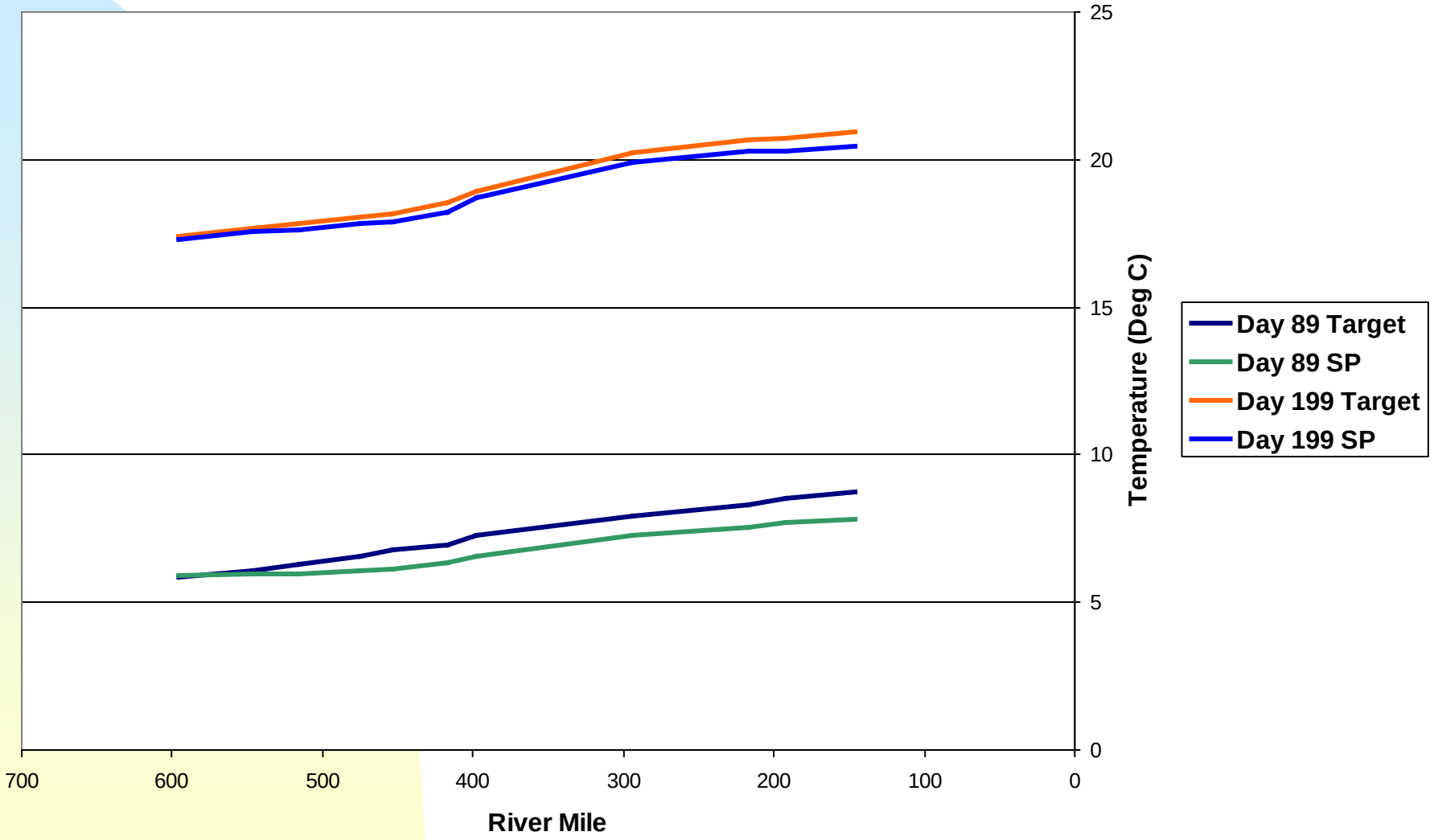
Target and Site Potential Temperatures along the Columbia



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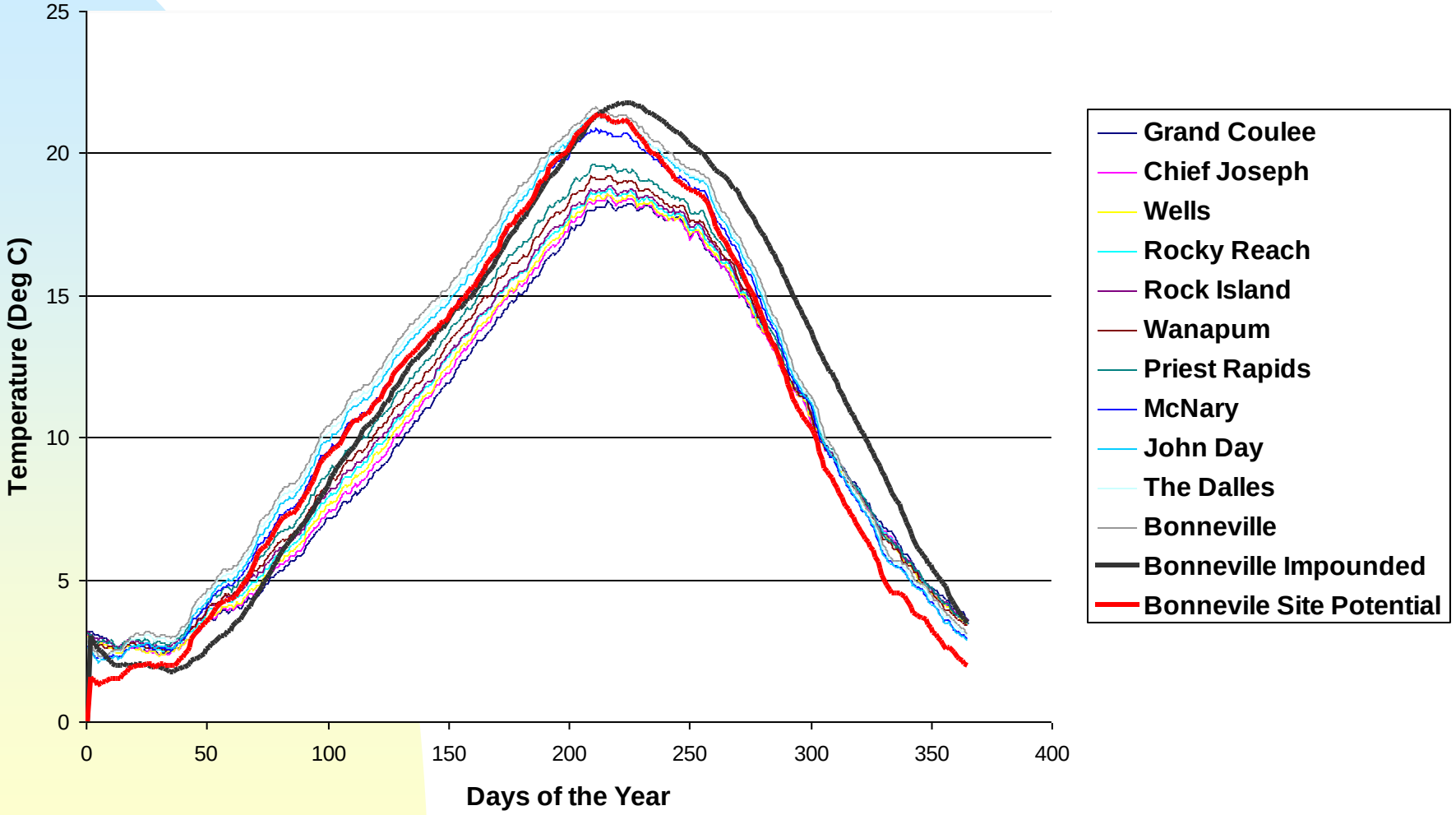
TMDL Temperatures at the Target Sites with Bonneville Site Potential and Impounded Temperatures



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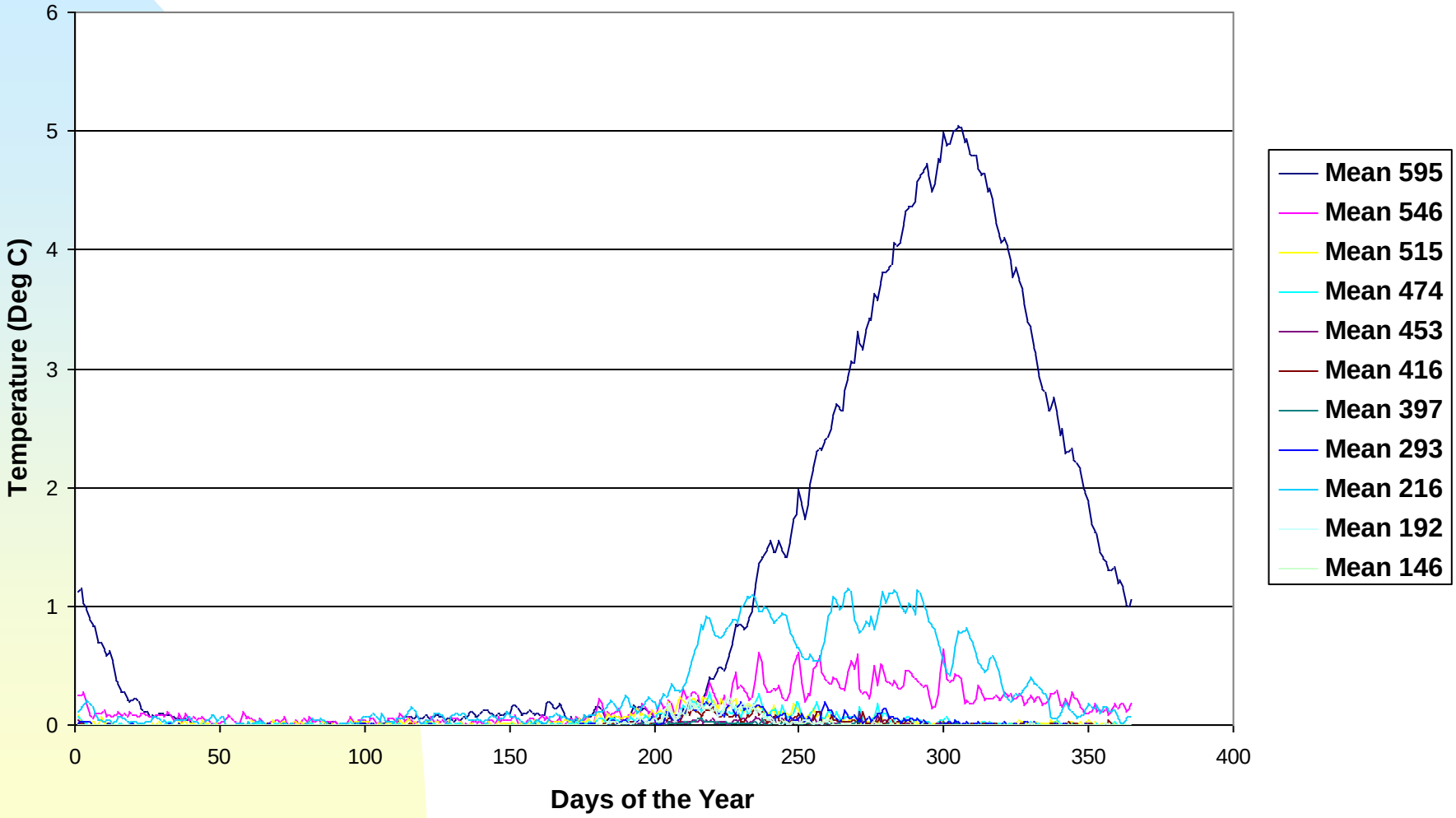
Temperature Improvements Needed at Each Columbia River Target Site



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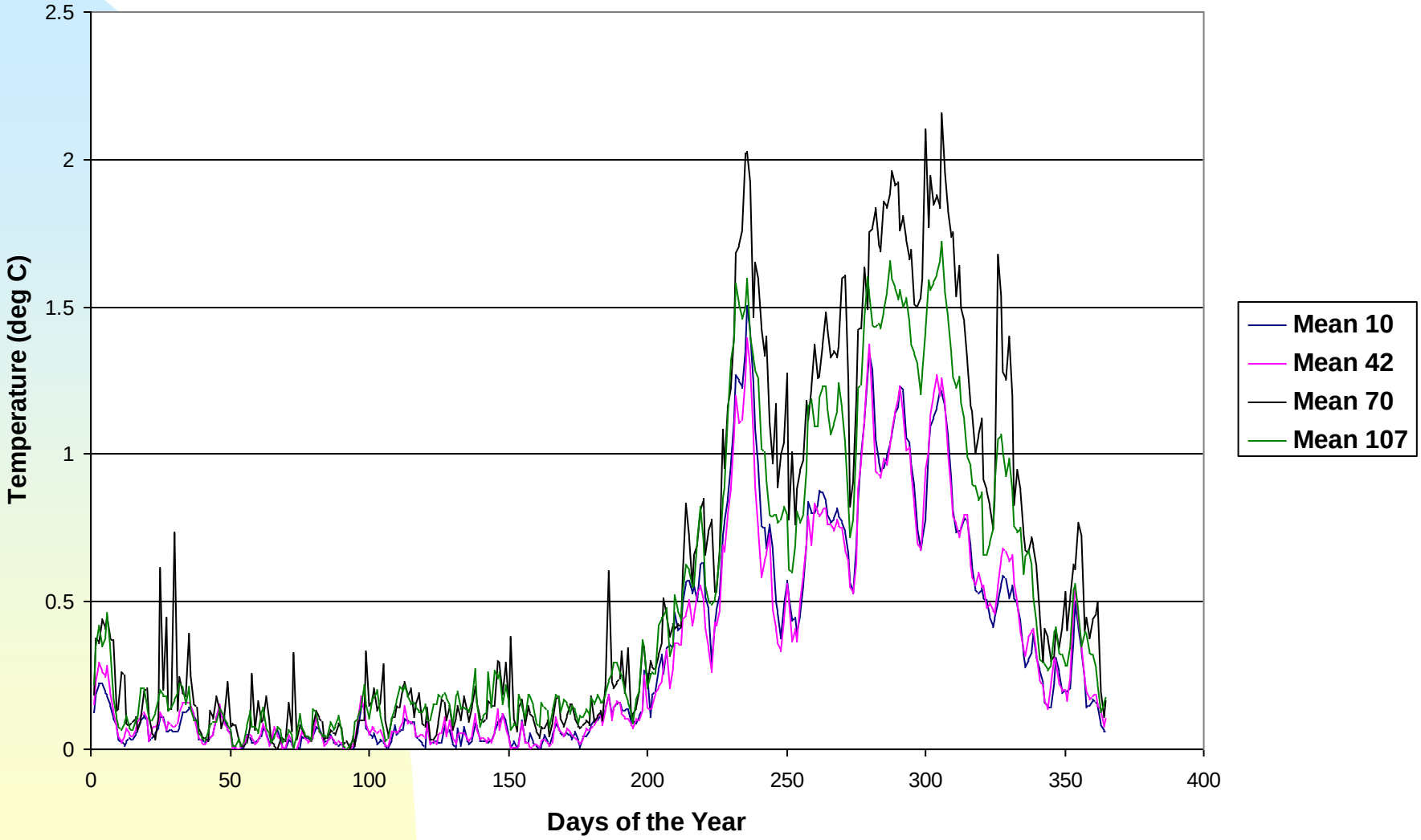
Temperature Improvements Needed at Each Snake River Target Site



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Part 2

Detailed discussion of the TMDL approach to establishing Loading Capacities and Allocations

1) **Determine Target Temperatures**
2) **Establish Loading Capacity**
3) **Allocate Available Load**

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Establish Loading Capacity

- Loading Capacity in this TMDL is in terms of Temperature rather than thermal load.
- Temperature is being used as "another appropriate measure" as per the regulations.
- Thermal load is not used because the dams are the most significant causes of temperature change but they do not discharge a thermal load to the river and they can alter load without affecting temperature.

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Establish Loading Capacity

For this TMDL the Loading Capacity is the Target Temperature.

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Allocate Available Load

The load available for allocation to dams, point sources, non-point sources, and future growth is the incremental increase allowed at each target site to achieve the target temperature:

- 0.02 C when the SP > criteria
- 0.15 C when the SP < criteria

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Allocation Table - Chief Joseph

Day	Upstream LC (°C)	LC (°C)	Increment (°C)	Dams Allocation (°C)	Other Sources (°C)	Future Growth (°C)
89	5.89	6.04	.15	.14	.005	.005
199	17.62	17.64	.02	.01	.005	.005

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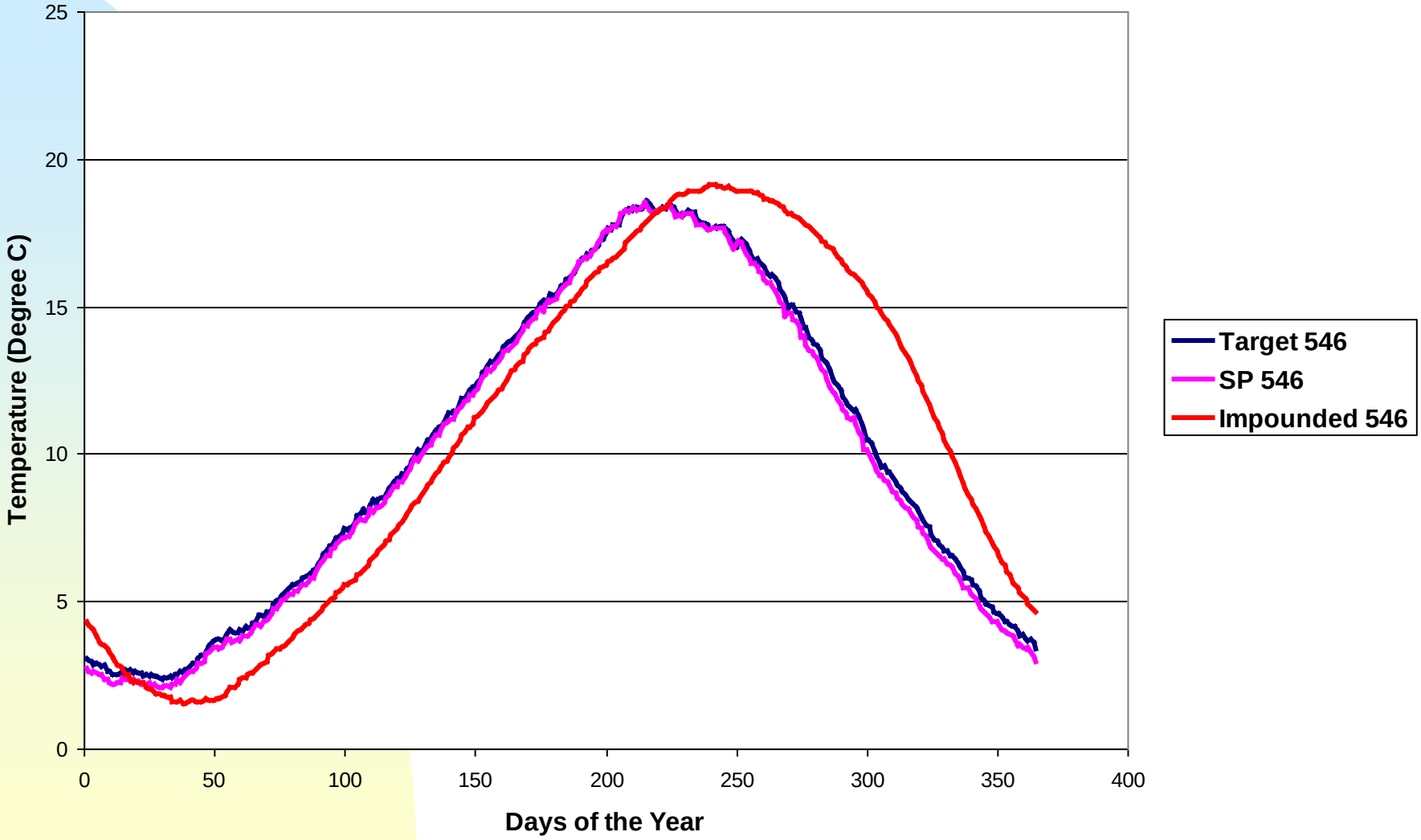
Chief Joseph Target, Site Potential and Impounded Temperatures



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Allocate Available Load

- What do these small allocations mean?
- Do they pass the laugh test?

- They mean that essentially no measurable increase in temperature due to human activity is allowed at each target site.
- There is sufficient loading capacity for existing point sources and some future growth.

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Point Sources

- 78 Point Sources
- Most cause less than 0.014 C increase.

  Bubble allocation for these
- About 12 Point Sources cause > 0.014 C increase.
- These will get individual allocations.

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Tributaries

One Tributary, the Umatilla River, has a TMDL for Temp. It will get its TMDL allocations in this TMDL.

188 Tribs do not have TMDLs. They will get their existing loads. Small Tributaries with no data may get bubble loads.

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Tributaries

- Essentially this TMDL is based on site potential in the main-stems.
- Water flowing into the TMDL from tributaries and boundary conditions is not at site potential.
- Improvement in temperature in the tributaries or at the boundary conditions could lower the site potential of the main-stems.
- We are doing an analysis of tributary temperature effects on main-stem site potential to develop thresholds of ΔT in the tributaries that would warrant re-opening this TMDL.

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Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Spokane R.	7.0	1.9
Okanagan	17	4.9
Yakima R.	17	4.8

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Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Deschutes	16	4.6
Willamette	3.2	0.92

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Snake Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Grande Ronde	6.0	1.7

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Measuring Compliance

Long Term System Level Compliance:

•Compliance with the target temperatures. That is, mean water temperature at the target sites equals the target temperatures.

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Anticipated Issues

- Very small allocations - far smaller than detection levels.
- TMDL doesn't account for river conditions at boundary and in tributaries.
- Dam specific compliance monitoring may be impossible in the short term.
- TMDL addresses daily average temperature.
- "Nothing can be done at dams to improve temperature."

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